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Evolution of Asteroarchaediscidae A. Miklukho-Maclay, 1957 in the Carboniferous

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Abstract—This paper discusses the evolution of the family Asteroarchaediscidae, occurring in Eurasia, North America, and North Africa and used in Viséan and Serpukhovian stratigraphy. In particular, the species composition of the euryfacial genus *Neoarchaediscus* is very important because species of this genus are used for biostratigraphy of the Viséan–Serpukhovian boundary beds and correlation of deep- and shallow-water facies. Members of the family Asteroarchaediscidae are present in the Verkhnyaya Kardailovka Section, a candidate for the global stratotype of the Serpukhovian Stage base.

Keywords: foraminifera, Archaediscida, Asteroarchaediscidae, *Neoarchaediscus*, Carboniferous, evolution

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INTRODUCTION

Members of the family Asteroarchaediscidae A. Miklukho-Maclay, 1957 are widespread marine benthic organisms important for stratigraphy. Representatives of Asteroarchaediscidae are particularly important for correlation of shallow-water and deep-water facies of the Serpukhovian Stage (Lower Carboniferous). The family Asteroarchaediscidae belongs to the superfamily Archaediscoidea Cushman, 1928, which also includes the family Archaediscidae Cushman, 1928 and, tentatively, the family Pseudovidalinidae Altiner, 1988. Archaediscoidea appeared in the Early Viséan and persisted through the Early Permian (Fig. 1). Most representatives of Archaediscoidea became extinct at the beginning of the Moscovian.

The evolution of Archaediscoidea is described in many papers (Miklukho-Maclay, 1956, 1957; Marfenkova, 1983; Vdovenko, 1993; Pirlet and Conil, 1973; Brenckle et al., 1987; Chermnykh, 1996; Kulagina, 2012); however, the taxonomic criteria used by various authors are different. The reference book on the systematics of small Paleozoic foraminifers (Vdovenko, 1993) uses a classification based on wall structure (Brenckle et al., 1987). However, this reference book does not give the species composition of the genera, and up to the present there is no accepted understanding of the generic assignment of some species, a situation that warrants their revision. It is particularly important to reach agreement on the taxonomy of species used as zonal index-species. For instance, this applies to *Neoarchaediscus postrugosus* (Reitlinger, 1949), the zonal species of the stratigraphic scale of Russia, and one of the markers of the Serpukhovian base.

ORIGIN AND EVOLUTION OF ASTEROARCHAEDISCIDAE

The family Asteroarchaediscidae includes members of Archaediscoidea in which the test varies in shape from discoid to subcylindrical and consists of a globular proloculus and second pseudotubular chamber with an axis varying from oscillating to almost planispiral in the last whorls. The test wall is usually unifoliate, hyaline-radial, sometimes with a very thin dark microgranular layer. This family is distinguished by the complete or partial filling of the chamber with calcite, which gives the test section a stellate appearance (Pl. 1, figs. 1–3). The filling of the tubular chamber can be complete (genera *Asteroarchaediscus*, *Permodiscus*) or partial (*Neoarchaediscus*, *Rugosoarchaediscus*, *Brenkleina*).

The family Asteroarchaediscidae appeared at a certain stage in the evolution of Archaediscoidea. According to Solovjeva (1966), who studied the evolution of fusulinoids, the rate of the evolutionary process is the main criterion allowing the recognition of evolutionary stages of foraminifers. Several stages with different evolutionary rates are recognized in the evolution of the superfamily Archaediscoidea (Kulagina, 2011). The Early Viséan (Late Radaevkian Time) corresponds to the stage of accelerated evolution of this